

Chapter 1

Quality Assurance of Air Monitoring

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1.0 Introduction

This chapter is designed to provide an overview of the minimum requirements for a quality assurance program for air monitoring networks. Requiring monitoring networks to meet these criteria allows the data from other monitoring networks to be compared in a meaningful way.

A quality assurance program encompasses all phases of ambient air sampling and data analysis. These phases include such things as site selection, monitoring equipment selection, audit/calibration equipment and procedures, sampling procedures, data validation, Chain-of-Custody, data reporting, precision/accuracy reporting, and meteorological issues (addressed in Chapter 9 of this manual). The Indiana Department of Environmental Management's (IDEM), Office of Air Quality (OAQ), Quality Assurance Manual (QAM) endeavors to address ambient monitoring and quality assurance issue requirements in a user-friendly format. Additional information, by parameter, is contained in each specific chapter. Prior to the implementation of any ambient monitoring network becoming operational, a working knowledge of all the applicable chapters in this manual is necessary by those personnel designated as Quality Assurance (QA) and Quality Control (QC).

2.0 Federal Requirements

There are three basic sections of the Code of Federal Regulations (CFR) Title 40, Protection of the Environment, which deal with Ambient Air Monitoring. 40 CFR Part 50 lists the National Primary and Secondary Ambient Air Quality Standards. 40 CFR Part 53 lists alternate equivalent air monitoring methods and procedures for obtaining equivalency. Finally, 40 CFR Part 58 gives detailed descriptions of monitoring methodology, network design and siting, PSD requirements, and quality assurance criteria. Additional Federal requirements are also given in USEPA Technical Assistance Documents and USEPA QA Guidance Documents. Designated quality assurance personnel should maintain a working knowledge of all applicable requirements. All monitoring and QA program requirements should be kept current and accessible.

3.0 Indiana Requirements

All intermittent and continuous air quality monitoring conducted in Indiana shall meet the requirements listed on the following pages. These requirements are the minimum needed for a competent monitoring program in Indiana.

3.1 Data Assessment Requirements

Air quality data must have precision and accuracy (P&A) assessments performed. These assessments are made on each monitor at each monitoring site. There are requirements for the methods used to assess P&A; such as, how complete the assessment is, how frequently P&A measurements are made, limits on how much deviation is allowed for measurements of precision and accuracy, and the determination of system bias. Table 1 lists all of these requirements.

This method of reporting is covered in detail in Chapter 13 of this manual. The data is reported to AQS, which is operated and maintained by the USEPA's Office of Enforcement and Compliance Assurance (OEAC).

Table 1
Minimum Data Assessment Requirements

Parameter Method	Assessment Method	Coverage	Frequency	Acceptable Completeness	Measured Quality Objectives
<u>PRECISION</u>					
<u>Automated</u> O ₃	Response check at .080-0.100 ppm	Each analyzer at each site	Once per 2 weeks	≥75% each site, ≥80% if PSD	Precision 7%, Bias ±7%
SO ₂ , NO ₂	Response check at .080-0.100 ppm	Same as above	Same as above	Same as above	Precision 10%, Bias ±10%
CO	Response check at 8.0-10.0 ppm	Same as above	Same as above	Same as above	Same as above
PM ₁₀	1 point flow check	Same as above	Once every month	Same as above	See Chapter 13 of this Manual
PM _{2.5}	Collocated samplers	15% within PQAQ	Once every 12 days	Same as above	See Chapter 13 of this Manual
<u>Manual</u> TSP, PM ₁₀ , Pb	Collocated Samplers	15% within PQAQ	Every 12 days (PSD every 6 days)	Same as above	±15%, In addition, PM ₁₀ collocated samples agree within 7% for concentration >80 µg/m ³ , 5 µg/m ³ when < 80 µg/m ³
PM _{2.5}	Same as above	15% within PQAQ	Every 12 days (PSD every 6 days)	Same as above	See Chapter 13 of this Manual
<u>Analytical</u> Pb	Collocated Filter analysis	Same as above	Over all 4 quarters	Same as above	See Chapter 13 of this Manual

(Table continued on next page)

Table 1
Minimum Data Assessment Requirements
(continued)

Parameter Method	Assessment Method	Coverage	Frequency	Acceptable Completeness	Control Limits
<u>ACCURACY</u>					
<u>Automated</u> SO ₂	Response check at .0500-.0999 ppm, .1500-.2599, .2600-.7999	Each analyzer Each site	25% SLAMS / qtr. (at least 1) and each site once per year. PSD each analyzer each qtr.	≥75% of total number possible, ≥80% for PSD	95% ±20%, 2s confidence limit for Level 2 conc. (.15-.20)
NO ₂	Response check at .0500-.0999 ppm, .1000-.2999, .3000-.4999	Same as above	Same as above	Same as above	Same as above
O ₃	Response check at .070-.089 ppm, .140-.169, .190-.259	Same as above	Same as above	Same as above	Same as above
CO	Response check at 3.000-7.999 ppm, 16.000-30.999, 40.000-50.000	Same as above	If 1 sampler, then twice/yr.	Same as above	Same as above
PM ₁₀	Check of sampler flow rate	Same as above	Same as above	Same as above	Same as above
<u>Manual</u> TSP, Pb, PM ₁₀	Check of sampler flow rate	Each sampler Each site	25% of network per qtr. (at least 1) and each site once per year.	Same as above	±15% at 95%, 2s confidence level
<u>Analytical</u> Pb	Check analytical system with Pb standard	Once per analysis	Each quarter	100% of all analysis	±15%
<u>ACCURACY AND BIAS</u>					
<u>Manual and Automated</u> PM _{2.5}	1. Check of sampler flow rate 2. Audit with reference method	25% of SLAMS (monitors with Conc. Affecting NAAQS violation status)	1. Minimum of every calendar quarter, 4 checks per year 2. Minimum 4 measurements per year		1. Actual flow rate indicated by sample 2. Particle mass concentration indicated by samples and by audit reference sampler

The following is a brief explanation of AQS:

The Air Quality System (AQS) contains ambient air pollution data collected by USEPA, state, local, and tribal air pollution control agencies from thousands of monitoring stations. AQS also contains meteorological data, descriptive information about each monitoring station (including its geographic location and its operator), and data quality assurance/quality control information.

The Office of Air Quality Planning and Standards (OAQPS) and other AQS users rely upon the system data to assess air quality, assist in Attainment/Non-Attainment designations, evaluate State Implementation Plans for Non-Attainment Areas, perform modeling for permit review analysis, and other air quality management functions. AQS information is also used to prepare reports for Congress as mandated by the Clean Air Act. AQS was reengineered from a mainframe application to a PC-based application. The PC-based application went into production status in January 2002. Today, State, Local, and Tribal agencies submit their data directly to AQS via this client/server application. Registered users may also retrieve data through the AQS application and through the use of third party software such as the Discoverer tool from Oracle Corporation. 2001.

3.2 Continuous Analyzer Calibration Requirements

Each individual analyzer should be calibrated in accordance with USEPA protocols and with the manufacturer's suggested guidelines. Analyzer calibrations must be in accordance with requirements outlined in this manual.

Calibration of an analyzer establishes the quantitative relationship between the actual pollutant concentration input (in ppm, $\mu\text{g}/\text{m}^3$, etc.) and the analyzer's response (chart recorder reading, output volts, digital output, etc). This relationship is used to convert subsequent analyzer response values to corresponding pollutant concentrations.

Calibrations and audits must be carried out at the field monitoring site by allowing the analyzer to sample test atmospheres containing known pollutant concentrations. The analyzer to be calibrated should be in operation for at least several hours (preferably overnight) prior to the calibration so that it is fully warmed up and its operation has stabilized. During the calibration, the analyzer should be operated in its normal sampling mode, and it should sample the test atmosphere through all filters, scrubbers, conditioners, and any other components used during normal ambient sampling and through as much of the ambient air inlet system as practicable.

Calibrations consist of two (2) types, a multi-point calibration and a Level 1 calibration. A multi-point calibration consists of three (3) or more test concentrations, which include a zero concentration (pollutant free air), a concentration between 80% and 90% of the full scale range of the analyzer being calibrated, and one (1) or more intermediate concentrations spaced approximately equally over the scale range. This multi-point calibration should be performed at the time of initial installation. A Level 1 calibration consists of a two-point analyzer calibration (zero and span only) which should be used when the analyzer's linearity does not need to be checked.

A multi-point calibration of an analyzer must be performed if any of the following conditions exist:

- A. A six (6) month period has lapsed since the most recent multi-point calibration.
- B. If all calibration points are not within $\pm 2\%$ of the full range of the analyzer (e.g., if the range is 0.5 ppm, then all measured values must be within .010 ppm of the standard).

A Level 1 calibration of an analyzer must be performed if any of the following conditions exist (the multi-point can always substitute for the Level 1 calibration):

- A. After an interruption of more than 24 hours of operation.
- B. Any repairs which may affect calibration, such as replacement of electronic boards, optics, solenoids, etc.
- C. Physical relocation of the analyzer.
- D. Any other indication of possible significant inaccuracy of the analyzer.
- E. If all calibration points are not within $\pm 2\%$ of the full range of the analyzer (e.g., if the range is 0.5 ppm, then the measured values must be within ± 0.010 ppm of the standard. Therefore, if the standard value introduced into the analyzer is .400 ppm, the measured value must be between .390 and .410 ppm.)

3.3 Continuous Analyzer Audit Requirements

With the exception of LEADS sites all continuous gas analyzers are audited *every two weeks*. Each audit consists of two phases; a precision check and a data validation check (Level 1 check). These biweekly precision and data validation Level 1 checks are done in conjunction with a 3 or 4 point accuracy audit (see performance check for each respective monitor) at least once per quarter. LEADS sites are audited every six weeks following the same criteria consisting of a precision check and a data validation check. The on-site calibrator is audited during this time to check how well it is functioning.

If applicable, each monitor is to have a daily zero and span check (Level 2) performed to distinguish the pattern of random and non-random variations.

3.3.1 Definitions of Level 1 check (data validation) and Level 2 check (refer to cumulative zero and span).

The Level 1 check consists of an artificial test atmosphere of the pollutant at a zero concentration and one upscale concentration between 70% and 90% of the measurement range of the analyzer. Once the analyzer's linearity has been established, the Level 1 check is performed biweekly on NON-LEADS sites and twice per quarter on LEADS sites.

The Level 1 check should be performed before the one-point precision check. The Level 1 checks are used: (1) to decide on the need for analyzer calibration; (2) to determine the validity of monitoring data; and (3) to determine the frequency of the recalibration control chart.

A Level 2, zero and span check is an “unofficial” check of an analyzer’s response. In a Level 2 check, the zero and span concentration may be generated by an internal or external analyzer check (e.g. electronic). This differs from the artificial test atmospheres (cylinder gases) used for the Level 1 checks. Level 2 checks are not intended as the basis for making zero or span adjustments, calibration updates, or adjustments of ambient data. The Level 2 checks should be conducted on a daily basis. The span should be one upscale concentration between 70% and 90% of the measurement range of the analyzer. The results from the Level 2 (zero and span) check should be used as follows: (1) when the cumulative zero or span drift of a Level 2 check exceeds the zero or span drift limits for calibration, a Level 1 check should be performed immediately and (2) to make a determination if the frequency of Level 1 checks should be increased (e.g., change the schedule of Level 1 checks from every two weeks to weekly).

Level 2 (Span Drift and Zero Drift) Control Chart

A control chart should be maintained for Level 2 span and zero checks. This chart will serve to identify drift patterns and preliminarily determine the need for a Level 1 check. The USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II, Part 1, Section 12 provides information on the construction and interpretation of control charts. It is recommended a $\pm 7.5\%$ be used to set the upper and lower limits of the control chart for span drift. More stringent control limits may be desired based on the operator's actual span and zero drift results.

However, in no case should the control limits be less stringent than the calibration limit concentration shown in Table 2. The control limit for zero drift is $\pm 2.0\%$ of the analyzer's range.

Control limits based on the operator's actual zero and span drift results may be calculated by the procedure described in the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume I:

- A. Using existing Level 2 zero and span drift data from similar analyzers in the network; or
- B. Using the calibration control limits of Table 2 until data from at least twenty (20) Level 2 span and zero checks have been accumulated.

In order to establish these control limits in a timely manner, zero and span checks should be performed daily. Statistically, three standard deviations for control limits are recommended as an indicator for a Level 1 calibration. These limits correspond to the 99.7% probability interval.

Frequent review and interpretation of the control chart is important. Various criteria are used to determine if an "out-of-control" condition exists for an analyzer. These criteria are described in the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II.

Table 2
Audit Matrix

Analyzer	Precision and Level 1 audit frequency	PPM precision check Concentration	Level 1 data validation check	Multi-point accuracy frequency (All Annually)	PPM multi-point accuracy concentration	Limits
SO ₂ Fluorescence Coulometric UV Photometry	Biweekly (LEADS sites twice per quarter)	.08-0.10	70-90% full scale response	A minimum of 25% of the total number of analyzers each quarter	.0500-.0999 .1500-.2599 .2600-.7999	If the obs. conc. is > 7.5% of the std. Conc.: recal. If > 15.0%, invalidate and recal.
CO Infrared	Same as above	8-10	Same as above	Same as above	3.000-7.999 16.000-30.999 40.000-50.000	Same as above
O ₃ UV Photometry Chemilum- inescence	Same as above	.08-0.10	Same as above	Same as above	.070-.089 .140-.169 .190-.259	Same as above
NO-NO _x - NO ₂ Chemilum- inescence	Same as above	.08-0.10 NO ₂ with .08-.12 remaining NO	Same as above	Same as above	.0500-.0999 .1000-.2999 .3000-.4999 with .08-.12 remaining NO	Same as above

For reporting of Precision and Accuracy checks, see Chapter 13 of the IDEM, OAQ, QA Manual.

All calibrators or audit equipment must meet the certification requirements of Chapter 6 of the IDEM, OAQ, QA Manual.

3.4 Continuous Sampler Checks

All continuous data is audited to assure correctness and completeness. Specific procedures and requirements are covered in Chapter 12 of the IDEM, OAQ, QA Manual. Table 3 lists requirements for continuous checks.

Table 3
Continuous Analyzer Checks

Type	Frequency	Limits	Action
Level 1	Once per two weeks or as determined by Level 2 check (LEADS sites every 6 weeks)	$\pm 7.5\%$ of standard $\pm 15.0\%$ of standard	Recalibration recommended Invalidate data and recalibrate
Level 2	Daily zeros Daily spans	3 std. Deviations of first 20 days zeros and spans Recal. Every 6 months	Investigate with Level 1 check, if monitor does not have a history of 3s, maintenance, recal.
Daily span Drift Level 2	Check SO ₂ , O ₃ , CO daily. See Chapter 12	SO ₂ $\pm 5\%$ of full scale O ₃ $\pm 5\%$ of full scale CO $\pm 5\%$ See Chapter 11	Research with Level 1 check, if needed, invalidate, and perform maintenance. Same as above Same as above
Daily zero Drift Level 2	Check daily See Chapter 12	SO ₂ ± 0.02 ppm O ₃ ± 0.01 ppm CO ± 1.0 ppm See Chapter 11	Same as above Same as above Same as above
Each site Each parameter SO ₂ , O ₃ , CO, NO, NO _x , NO ₂	See Chapter 12	See Chapter 12	See Chapter 12

3.5 Intermittent Sampler Calibration Requirements

Additional information for any of the following requirements may be found in Chapter 7 of this Manual.

3.5.1 Pb, TSP, PM₁₀

Intermittent Pb, TSP, or PM₁₀ samplers should be recalibrated when:

- A. The sampler's flow is greater than $\pm 5.0\%$ from the auditor's flow.
- B. A motor is replaced.
- C. Any repairs to a flow control device are performed.
- D. The difference between initial and final flows is greater than $\pm 10\%$.
- E. Any other indication of inaccurate flow is found.

F. A period of three months has elapsed since the last calibration.

3.5.2 TEOM, BAM, SHARP, and PM_{2.5}

Continuous monitors (*TEOM, BAM, and SHARP*) and intermittent PM_{2.5} samplers are to be recalibrated when:

- A. The sampler's flow is greater than $\pm 4.0\%$ (PM_{2.5} and BAM), $\pm 5\%$ (SHARP), $\pm 10\%$ (TEOM) from the auditor's flow.
- B. A pump is replaced.
- C. Any repairs to a flow control device are performed.
- D. Any other indication of inaccurate flow is found.
- E. A period of one year has elapsed since the last calibration.
- F. New software is loaded.

3.6 Intermittent Sampler Audit Requirements

The data assessment requirements of Section 3.1 list an accuracy or data validation audit requirement of each analyzer every two weeks. It is recommended that all TSP, Pb, or PM₁₀ samplers have data validation audits performed monthly. PM_{2.5} samplers, however, are required to have a data validation audit every three months.

3.7 Intermittent Sampler Checks

The data check process, for intermittent sampling analyzers, requires certain "audits" to be performed on the sampling portion (filter and data card) and the analytical portion (filter weighing and calculation). Table 4 summarizes and references these requirements.

Table 4
Intermittent, BAM, SHARP, and TEOM Data Checks

Parameter	Requirement	Corrective Action
Sample Filters	<ol style="list-style-type: none"> 1. Elapsed time 1440 min. must be within ± 60 min. 2. All data card information must be complete. 3. No bleed off. 4. No missing filter pieces. 5. No contamination. 6. Initial and final standard flows of TSP & Pb must be within 1.1 to 1.7 m³/min. 7. Initial and final actual flows of PM₁₀ sequential 2025 must be within 1.02 to 1.24 m³/min on sample day. 8. PM_{2.5} and continuous flows 16.67 lpm actual flow $\pm 10\%$ on sample day. 9. Initial and final flows must agree with $\pm 10\%$. 10. Orifice and BIOS must be calibrated annually. 	<p>See Chapters 7 and 11 See Chapters 7 and 11 See Chapters 7 and 11 See Chapters 7 and 11 See Chapters 7 and 11 See Chapters 7 and 11</p> <p>See Chapters 7 and 11</p> <p>See Chapters 7 and 11 See Chapters 7 and 11 See Chapter 6</p>
Filter Conditioning: PM ₁₀ , Pb	<ol style="list-style-type: none"> 1. Temp. 15 to 30 °C (± 3 °C) 2. R.H. < 50% ($\pm 5\%$) 	See Chapter 7
PM _{2.5}	<ol style="list-style-type: none"> 1. Temp. 20 to 23 °C (± 2°C) / 24 hrs 2. R.H. < 30% - 40% ($\pm 5\%$) / 24 hrs 	See Chapter 7
Filter Analysis for Hi-vol method: PM ₁₀	<ol style="list-style-type: none"> 1. 7% with a minimum of 3 exposed filters re-weighed agree within ± 5.0 mg. 2. 7% with a minimum of 3 unexposed filters re-weighed must agree within ± 2.8 mg. 3. 7% of calculations are recalculated and agree within $\pm 3\%$. 	See Chapter 7
Filter Analysis: PM _{2.5}	<ol style="list-style-type: none"> 1. Neutralize electrostatic charge. 2. Stabilize balance to within ± 2 μg. Drifts < 3 μg in 5-10 sec's. 3. Working Std. must agree within ± 3 μg of certified values. 4. The lab blank filter must agree within 15 μg. 5. The field blank filter measurements must agree to within 30 μg. 6. For a group up to 50, 4 filters must be re-weighed and agree within 30 μg. 7. For a group greater than 50, 7 filters must be re-weighed and agree within 30 μg. 	See Chapter 7
Filter Analysis: PM ₁₀	<ol style="list-style-type: none"> 1. Neutralize electrostatic charge. 2. Stabilize balance to within ± 4 μg of true zero. 3. Working Std. must agree within ± 2 μg of 10 mg check weight. 4. The lab blank filter must agree within ± 15 μg. 5. The field blank filter measurements must agree to within ± 30 μg. 6. Per weighing session 1 filter (or 10% per weighing session) must be re-weighed and agree within 15 μg. 	

4.0 Network Design and Probe Siting Criteria

4.1 Introduction - Objectives and Spatial Scale

Monitoring networks must be designed in such a way that the data obtained is representative of the appropriate area to meet monitoring objectives. This section discusses the relationship between spatial scale and the purposes for which the data should be used. USEPA has additional details for other parameters, which are contained in 40 CFR Part 58, Appendix D.

4.1.1 Matching Monitoring Objectives and Spatial Scales

When designing a monitoring program for SLAMS/NAMS networks, one of the following six (6) objectives should be considered:

- A. Determine the highest concentrations expected to occur in the area covered by the network.
- B. Determine representative concentrations in areas of high population density.
- C. Determine the impact of specific sources on ambient pollutant concentrations.
- D. Determine general background concentration levels.
- E. Determine the extent of regional transport among populated areas, and in support of secondary standards.
- F. Determined welfare-related impacts in the more rural and remote areas.

For each of these objectives, there are appropriate spatial scales for providing a representation of the concentrations. This manual defines the various scales as follows (unless otherwise specified):

Micro Scale - Concentrations representative of the air in an area with dimensions ranging from several meters up to 100 meters.

Middle Scale - Concentrations representative of the air in an area with dimensions ranging from 100 to 500 meters.

Neighborhood Scale - Concentrations representative of the air in an area with dimensions ranging from 0.5 to 4.0 kilometers.

Urban Scale - Concentrations representative of the air in an area with dimensions ranging from 4.0 to 50.0 kilometers.

Regional Scale - Concentrations representative of the air in a large, usually rural area of homogeneous geography extending from tens to hundreds of kilometers.

National and Global Scales - These scales represent concentrations characterizing the nation or the globe as a whole.

Table 5 shows the relationship between monitoring objective and spatial scale. These are generally the only scales that should be used.

Table 5
Objectives and Monitoring Scale

Monitoring Objective	Appropriate Siting Scales
Highest Concentration	Micro, Middle, Neighborhood (sometimes Urban)
Population Exposure	Neighborhood, Urban
Source Impact	Micro, Middle, Neighborhood
General/Background	Neighborhood, Regional
Regional Transport	Urban/Regional
Welfare – Related	Urban/Regional

4.1.2 Specific Pollutant Scales

The appropriate scale of representativeness varies based on the pollutant and the monitoring objective. This is because pollutants behave differently from each other in the atmosphere and because the sources of pollutants vary greatly. Table 6 gives the appropriate scales for each pollutant.

Table 6
Summary of Spatial Scales SLAMS, NAMS, PAMS, and Open Path Sites

Spatial Scale	Scale Applicable for SLAMS							Scale Applicable for NAMS							PAMS	OP
	SO ₂	CO	O ₃	NO ₂	Pb	PM ₁₀	PM _{2.5}	SO ₂	CO	O ₃	NO ₂	Pb	PM ₁₀	PM _{2.5}		
Micro		*			*	*	*		*			*	*	*1		
Middle	*	*	*	*	*	*	*					*	*	*1		*
Neighborhood	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Urban	*		*	*	*	*	*			*	*			*2	*	*
Regional	*		*		*	*	*							*2		*

Note: 1. Only permitted if representative of many micro scale environments in a residential district (for middle scale, at least two).

2. Either urban or regional scale for regional transport sites.

Taking into consideration monitoring objectives and the appropriate siting scales for each pollutant, it is possible to design a network that will yield high quality data. The following sections of this manual give specific siting information for each major pollutant.

4.2 Sampling Probes and Manifolds

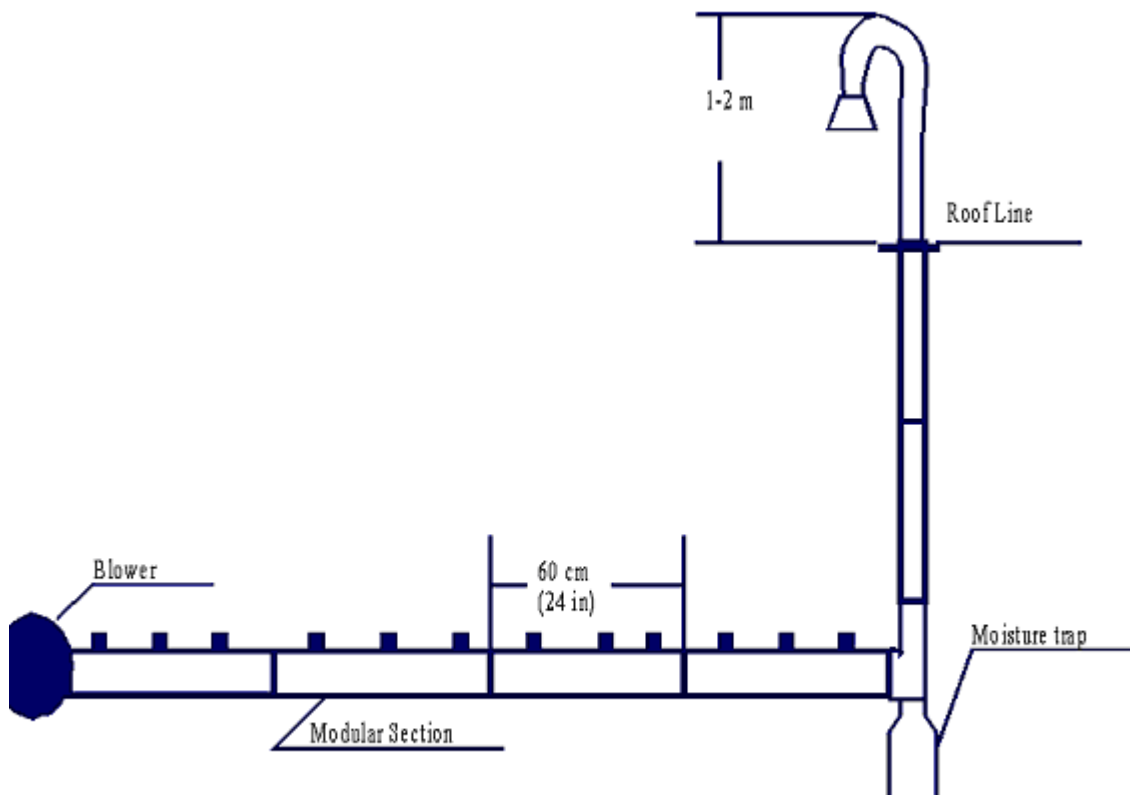
4.2.1 Design of Probes and Manifolds for Automated Methods

Some important variables affecting the sampling manifold design are the diameter, length, flow rate, pressure drop, and construction materials. Considerations for these parameters are discussed below for the *conventional manifold* design.

4.2.1.1 Conventional Manifold Design

A conventional horizontal manifold system should be constructed of inert materials such as Pyrex glass and/or Teflon, and modular sections to enable frequent cleaning. The system (Figure 1) consists of a vertical “candy cane” protruding through the roof of the shelter with the horizontal sampling manifold connected by a tee to the vertical section. Connected to the other vertical outlet of the tee is a bottle for collecting heavy particles and moisture before they enter the horizontal section. A small blower, 1700 lpm at 0 cm of water static pressure, is at the exhaust end of the system to provide a flow through the system of approximately 3 to 5 times the total sampling requirements or at a rate equal to the total sampling requirement plus 140 lpm.

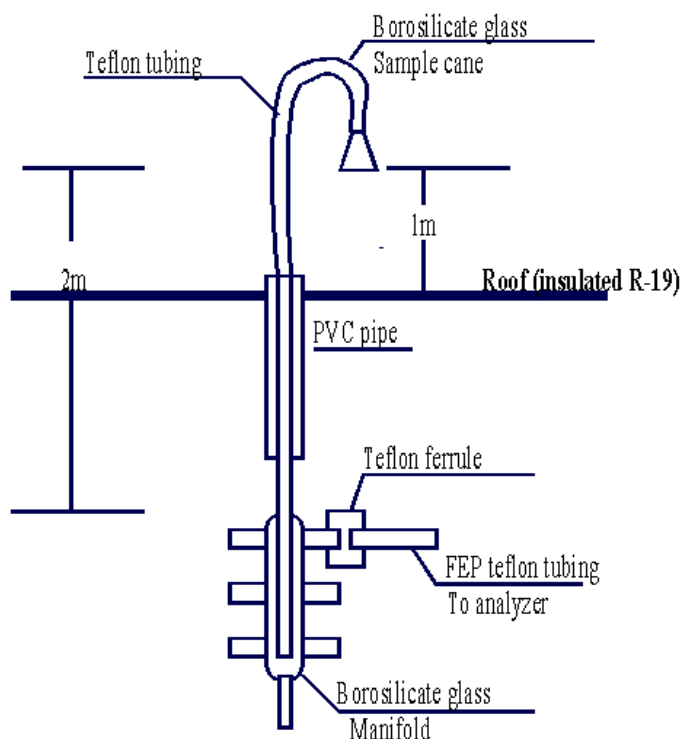
Figure 1
Conventional Manifold System



4.2.1.2 Alternate Manifold Design

This type of manifold system is known as the California Air Resources Board (CARB) or “Octopus” and is illustrated in Figure 2. The “CARB” has a reduced profile, i.e., there is less volume in the cane and manifold; therefore, there is less of a need for bypass flow. These manifolds allow more options than the other conventional manifolds. If the combined flow rates are high enough with the instruments at the monitoring location, bypass flow devices are not required.

Figure 2
Alternate Manifold Design



This section will supply detailed siting information for each monitoring parameter. Representative scales will be discussed, and then probe-siting criteria will be listed. Further information can be found in 40 CFR Part 58 Appendices D and E.

4.2.1.3 Residence Time Determination

The residence time of pollutants in the manifold is critical. Residence time is defined as the amount of time that it takes for a sample of air to travel from the opening of the cane inlet to the instrument and is required to be less than 20 seconds for reactive gas monitors. It is recommended that the residence time within the manifold and sample lines to the instrument be less than 10 seconds. If the volume of the manifold *does not allow this to occur*, then a blower or vacuum pump can be used to decrease the residence time. The residence time for a manifold is determined in the following way. First the volume of the cane, manifold, and sample lines must be determined using the following equation:

$$\text{Total Volume} = C_v + M_v + L_v$$

Where:

C_v	=	Volume of sample cane and extensions
M_v	=	Volume of sample manifold and trap
L_v	=	Volume of instrument lines

Each of the components of the sampling system must be measured individually. To measure the volume of the components, use the following equation:

$$V = \pi * (d / 2)^2 * L$$

Where:

V = Volume of the component

π = 3.14159

L = Length of the component

d = inside diameter

* = multiply, / = divide

Once the total volume is determined, divide the volume by the flow rate of all instruments. This will give the residence time. If the residence time is greater than 10 seconds, attach a blower or vacuum pump to increase the flow rate and decrease the residence time.

Generally, it has been determined that there are no significant losses of reactive gas (O₃) concentrations in conventional 13 mm inside diameter sampling lines of glass or Teflon if the sample residence time is 10 seconds or less. This holds for sample lines up to 38 meters (125 ft) in length, which collect substantial amounts of visible contamination due to ambient aerosols. However, when the sample residence time exceeds 20 seconds, a loss is detectable and at 60 seconds the loss is nearly complete. Care must also be taken to ensure that a pressure drop on the manifold does not exceed .25 inches. A large drop may result in a leak. A certified manometer can be used to measure the pressure drop. This measurement is recommended annually.

4.2.2 Ozone (O₃)

4.2.2.1 Representative Scales

- A. Middle Scale stations (SLAMS only) represent conditions close to sources of NO, such as roads, where suppression of O₃ would be expected.
- B. Neighborhood Scale stations represent conditions of peak concentration in areas with similar factors influencing the concentration. A station downward (predominate summer/fall wind direction) of the central business district on the fringes of town might be classified neighborhood.
- C. Urban Scale stations give data on generalized concentrations over a large urban area. These stations are useful in designing area wide control strategies. Urban scale stations can also be used to measure high concentrations in an area downwind from high precursor emissions.
- D. Regional Scale stations (SLAMS only) are useful for determining the ozone that is transported into an area.

4.2.2.2 Probe Siting Criteria

4.2.2.2.1 Horizontal and Vertical Probe Placement

See Chapter 2, Section 2.1

4.2.2.2.2 Spacing from Obstructions

See Chapter 2, Section 2.2

4.2.2.2.3 Spacing from Roads

See Chapter 2, Section 2.3

4.2.2.2.4 Spacing from Trees

See Chapter 2, Section 2.4

4.2.3 Sulfur Dioxide (SO₂)

4.2.3.1 Representative Scales

- A. Middle Scale stations are most representative of concentrations in urban areas and are useful for assessing the effectiveness of control strategies as well as for monitoring episodes.
- B. Neighborhood Scale stations are representative of suburban or less densely populated areas. These stations are useful for predicting concentrations in growth areas.
- C. Urban Scale stations are representative of concentrations in an entire urban area.
- D. Regional Scale stations are representative of background concentrations.

4.2.3.2 Probe Siting Criteria

4.2.3.2.1 Horizontal and Vertical Probe Placement

See Chapter 3, Section 2.1

4.2.3.2.2 Spacing from Obstructions

See Chapter 3, Section 2.2

4.2.3.2.3 Spacing from Trees

See Chapter 3, Section 2.3

4.2.4 Carbon Monoxide (CO)

4.2.4.1 Representative Scales

- A. Micro Scale stations represent concentrations in street canyons or near major roadways. These sites reflect peak concentrations and must be representative of concentrations in several areas of a city.
- B. Middle Scale stations (SLAMS only) are representative of long stretches of urban streets, such as strip development and freeway corridors. Middle scale would also include indirect sources, such as shopping centers and office building parking lots.
- C. Neighborhood Scale stations are representative of concentrations in areas of high population density and high traffic density. These stations need to be representative of urban regions with dimensions of a few kilometers and should be representative of similar areas in other parts of town.

4.2.4.2 Probe Siting Criteria

4.2.4.2.1 Horizontal and Vertical Probe Placement

See Chapter 4, Section 2.1

4.2.4.2.2 Spacing from Obstructions

See Chapter 4, Section 2.2

4.2.4.2.3 Spacing from Roads

See Chapter 4, Section 2.3

4.2.4.2.4 Spacing from Trees

See Chapter 4, Section 2.4

4.2.5 Oxides of Nitrogen (NO, NO₂, NO_x) and Total Reactive Oxides of Nitrogen (NO_y)

4.2.5.1 Representative Scales

- A. Middle Scale (SLAMS only) stations represent public exposure to NO₂ in populated areas. Stations closer to roadways than allowed in Table 9 must be classified as middle scale.
- B. Neighborhood Scale stations are placed in the location with the highest density of NO_x emissions such as the fringe of an urban business district. These stations measure the photochemical production of NO₂.
- C. Urban Scale stations must be located downwind from areas of high emissions and are used to measure the NO₂ produced from the reaction of NO and O₃. These stations are normally located downwind in the predominant winter wind direction or in areas where there are high O₃ concentrations and high NO₂ emissions.

4.2.5.2 Probe Siting Criteria

4.2.5.2.1 Horizontal and Vertical Probe Placement

See Chapter 5, Section 2.1

4.2.5.2.2 Spacing from Obstructions

See Chapter 5, Section 2.2

4.2.5.2.3 Spacing from Roads

See Chapter 5, Section 2.3

4.2.5.2.4 Spacing from Trees

See Chapter 5, Section 2.4

4.2.6 Total Suspended Particulate (TSP), PM_{2.5} and PM₁₀

4.2.6.1 Representative Scales

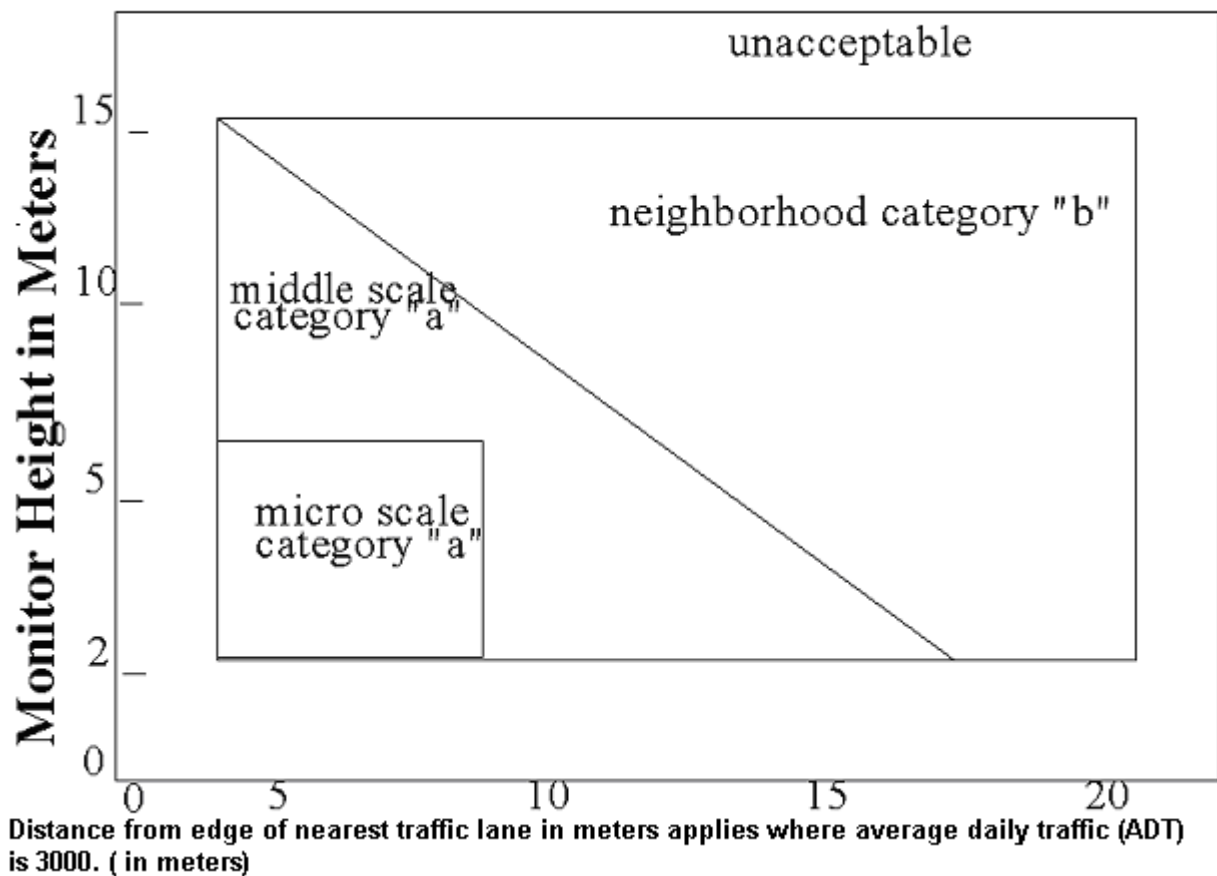
- A. Micro Scale stations are used to determine the maximum impact on the public in street canyon type situations.
- B. Middle Scale stations should be used to assess short term public exposure and the contribution of indirect sources.
- C. Neighborhood Scale stations should be used to determine trends and compliance with standards. These stations often give an indication of concentrations in similar neighborhoods. This definition also includes industrial and commercial neighborhoods.
- D. Urban Scale stations are useful for tracking citywide trends.
- E. Regional Scale stations supply information about sparsely populated areas or about pollutant transport.

4.2.6.2 Probe Siting Criteria

- A. Two (2) to fifteen (15) meters high (see Figure 3) for TSP, PM_{2.5}, and PM₁₀. The exception to this rule is PM₁₀ micro scale.
- B. Two (2) to seven (7) meters high for PM₁₀ micro scale (see Figure 3).
- C. Two (2) meter separation from walls, parapets, etc.
- D. Twenty (20) meters from the drip line of trees.

- E. The probe must be two times (2 X) as far away from an obstruction as that obstruction extends above the sample inlet (2 X rule).
- F. At least 270° around the sample inlet must be unrestricted and the 270° arc must include the prevailing wind direction for the season of expected highest concentration (270° rule).
- G. See Figures 3 and 4 for spacing from roads.
- H. Must be in a paved area or an area with vegetative ground cover.
- I. Collocated samplers two (2) to four (4) meters apart.
- J. Collocated PM_{2.5} samplers one (1) to four (4) meters apart.

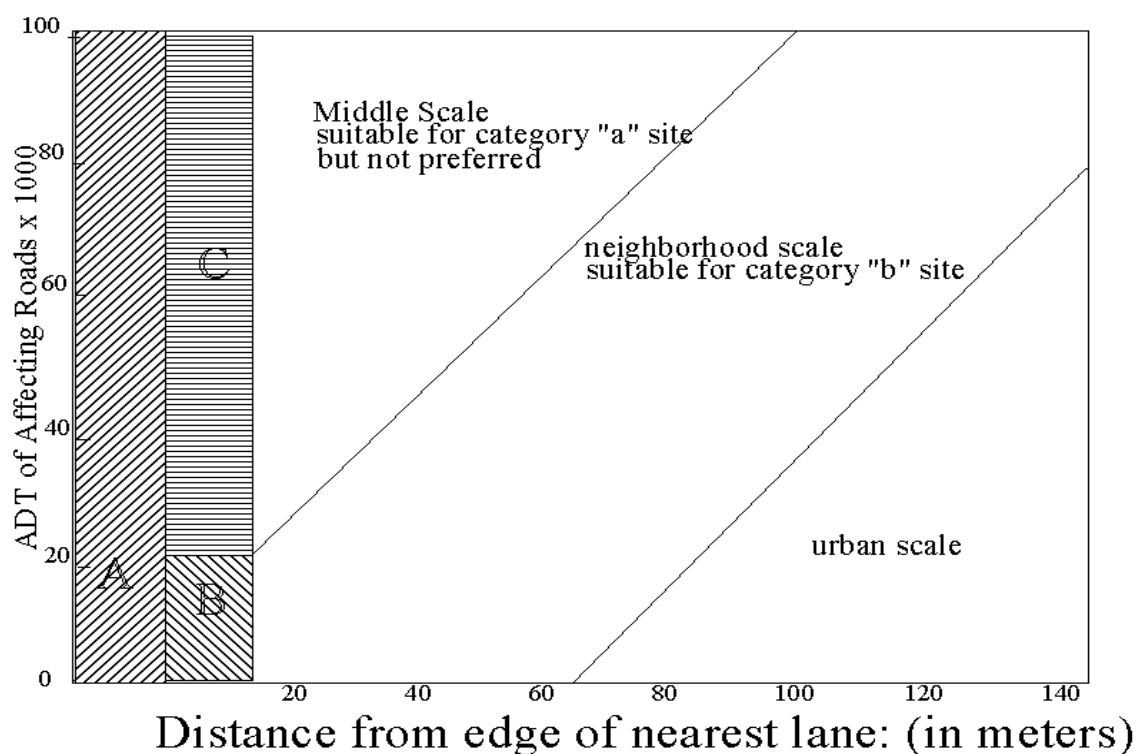
Figure 3
Acceptable Areas for TSP, PM_{2.5} and PM₁₀
Micro, Middle, and Neighborhood Scale Samplers



Category A: Community oriented site in area of maximum concentration.

Category B: Area of poor air quality with high population density or representative of maximum population impact.

Figure 4
Acceptable areas for $PM_{2.5}$ and PM_{10}
Micro, Middle, Neighborhood, and Urban Samplers



- A. Unacceptable at any traffic volume
- B. Unacceptable as category (a) site.
- C. Preferred area for category (a) site. Use micro scale if monitor is two to seven meters high, middle scale otherwise.

4.2.7 Lead (Pb)

4.2.7.1 Representative Scales

- A. Micro Scale - This scale is the preferred scale for Pb monitoring. This category (a) monitor should be located adjacent to the roadway with the largest traffic volume. If a micro scale station cannot be found, a middle scale station is acceptable as category (a). A micro scale station would be located in areas such as street canyons and traffic corridors. Point sources, such as, lead smelting, battery recycling, and primary copper smelting facilities are sites that should be monitored. For non-roadway sites (e.g., near point sources), micro scale may extend up to 100 meters.

- B. Middle Scale - For roadway sites, middle scale extends 50-150 meters. For other types of sites, middle scale could extend 100-500 meters. Middle scale is useful for sites such as schools near major highways.
- C. Neighborhood Scale - This type of station should represent conditions where children live and play, as they are more susceptible to the effects of lead.
- D. Urban Scale - These stations should be representative of concentrations over an entire urban area. These are useful for assessing trends in area wide air quality.
- E. Regional Scale - These stations are used to determine background concentrations.

4.2.7.2 Probe Siting Criteria

4.2.7.2.1 Vertical Probe Placement:

Micro scale lead sites are required to have sampler inlets between 2 and 7 meters above ground level.

4.2.7.2.2 Spacing from Obstructions

See Chapter 7, Part 2, Section 4.1

4.2.7.2.3 Spacing from Roads: (Micro and Middle Scale)

- A. For micro scale traffic corridor sites, the location must be between 5 and 15 meters from the major roadway.
- B. For micro scale street canyon sites the location must be between 2 and 10 meters from the roadway.
- C. For middle scale sites, a range of acceptable distances from the roadway can be found in 40 CFR Part 50, Appendix L.

4.2.7.2.4 Spacing from Trees: (Micro, Middle (A), and Neighborhood (B))

See Chapter 7, Part 2, Section 4.1

4.2.8 Air Toxics (VOC's, NMOC's, TO-15's, PAMHC's, Carbonyl's, Lead)

4.2.8.1 General Project Description

See Chapter 8, Section 1.0

4.2.8.2 Quality Assurance Objectives

See Chapter 8, Section 1.6

4.2.8.3 Sampling Procedures

See Chapter 8, Sections 3.2, 4.2, 5.2, 6.0

4.2.8.4 Chain-of-Custody

See Chapter 8, Sections 3.3, 4.3, 5.3

4.2.8.5 Calibration Procedures and Frequency

See Chapter 8, Sections 3.5, 4.5.

4.2.8.6 Analytical Equipment

See Chapter 8, Sections 3.4, 4.4, 5.4

4.2.8.7 Quality Control and Quality Assurance

See Chapter 8, Sections 3.8, 4.8, 5.6, 5.7, 6.1

4.2.8.8 Systems Audits

See Chapter 8, Sections 3.10, 4.10, 6.1

5.0 Air Monitoring Resource Criteria

5.1 Staffing Criteria

- A. Staff size, organization, qualifications, and utilization must be adequate to achieve the results in the program plan commitments. These should include at least one person designated as quality control officer.
- B. A formal staff training format should be developed to train new employees and periodically update employees' skills and program operations. Formal staff training should be coordinated with the Quality Assurance Section of the Office of Air Quality on a semi-annual basis for those person(s) engaged in operating and calibrating continuous analyzers. Standard literature references should be readily available to all staff members including the Federal Register, manufacturer's instrument manuals, and quality assurance guideline documents related to the program objectives.

Table 7
Performance Specifications for Automated Methods

Performance Parameter	Units	Sulfur Dioxide (SO ₂)	Photochemical Oxidants (O ₃)	Carbon Monoxide (CO)	Nitrogen Dioxide (NO ₂)
Range	PPM	0-0.5	0-0.5	50.0	0-0.5
Noise	PPM	.005	.005	0-.50	.005
Lower Detectable Limit	PPM	.01	.01	1.0	.01
Each Interferant	PPM	±.02	±.02	±1.0	±.02
Total Interferant	PPM	.06	.06	1.5	.04
Zero Drift	12 + 24 hr. ppm	±.02	±.02	±1.0	±.02
Span Drift					
20% of Upper range limit	Percent	±20.0	±20.0	±10.0	±20.0
80% of Upper Range Limit	Percent	±5.0	±5.0	±2.5	±5.0
Lag time	Minutes	20	20	10	20
Rise time	Minutes	15	15	5	15
Fall time	Minutes	15	15	5	15
Precision					
20% of Upper Range Limit	PPM	.01	.01	.5	.02
80% of Upper Range Limit	PPM	.015	.01	.5	.03

Note: Analyzers for SO₂, O₃, and NO-NO_x that have a range greater than that listed in this table must meet the requirements of 40 CFR Part 53 and/or contained in USEPA listing of designated reference or equivalent analyzers. NCORE performance specifications can be found in the chapters covering each of the specific parameters.

5.2 Ozone (O₃)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program. The following equipment is required:

- A. Ozone Analyzer – which meets the requirements of the Federal Reference or equivalent method or grandfather clause in accordance with 40 CF R Part 53 and Table 11.
- B. Calibration System to include:
1. Air flow controller
 2. Ozone generator
 3. Dilution system
- C. 40 CFR Part 50, Appendix D specifies the calibration procedures for ambient ozone monitors will be based on ultraviolet photometry or on alternative transfer standards that are traceable to UV Photometry. Chapter 2, of this manual, lists the specific requirements for all of the above.
- D. Flow Meters - capable of measuring flow rates over the operating and calibration range of the instrument, (40 CFR Part 50, Appendix D) output from system must be measurable from two (2) to fifty (50) liters/min $\pm 5\%$.
- E. Data Recording Device - for data collection, such as a strip chart recorder or a computer.

Table 8
Ozone Equipment Procurement Matrix

Equipment	Acceptance	Frequency and Method of Measurement	Action if Requirement not Met
Ozone Analyzer	EPA designated method equipment	Mfg. should provide a strip chart recording of the performance	Return to Mfg.
Recorder	Compatible with Analyzer output	Check upon receipt. Calibrate speed & output once per year.	Return to supplier
Sample lines	Teflon	Check upon receipt	Return to supplier
Calibration equipment	Chapter 2 of the QA manual	See same	Return to supplier
Flow meter	2 to 15 lpm $\pm 5\%$	Check upon receipt	Return to supplier
Ethylene	Pre-purified C.P. grade minimum	Mfg. should supply	Return to supplier

Additional equipment, that may be required for a particular agency's calibration use, is included in Table 12.

5.3 Total Suspended Particulate, PM_{2.5} and PM₁₀

5.3.1 TSP

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to maintain, operate, calibrate, and assure the data quality in the monitoring program. The following equipment is required:

5.3.1.1 TSP Sampler Specifications

- A. High Volume Samplers must meet the requirements of 40 CFR Part 50, Appendix B. In general, samplers must be capable of passing ambient air through a 406.5 cm portion of a 20.3 by 25.4 cm glass fiber filter at a rate of at least 1.7 m³/min for 24 hours with the voltage ranging from 110 to 120 with third wire safety grid. The shelter should be made of heavy gauge aluminum or painted exterior plywood, such that the filter is protected from precipitation and debris by a gable roof, and be rectangular in shape.
- B. A flow rate measuring device meeting the specifications of 40 CFR Part 50, Appendix B 7.4 (Marked in arbitrary units from 0-50/70 and capable of being calibrated).
- C. An orifice calibration unit with electronic manometer meeting the specifications of the Federal reference or equivalent 40 CFR Part 50 Appendix B 7.8, or Chapter 7 of IDEM QA manual. An orifice calibration unit consists of a metal tube 7.6 cm (inside diameter), 15.9 cm in length with a static pressure tap 5.1 cm from one end. The tube nearest the pressure tap is flanged to about 10.8 cm (outside diameter) with a male thread of the same size as the inlet end of the high volume air sampler. A single metal plate 9.2 cm (diameter) X .24 (thick) and a central orifice 2.9 cm in diameter is held in place at the air inlet with a female threaded end. Resistance plates with 5, 7, 10, 13, and 18 uniform diameter holes are used to simulate the resistance of filters as they load with particulate matter. A three (3) hole plate may be used in lieu of a five (5) hole plate. For a variable orifice uses a filter instead of plates.
- D. A positive displacement meter system meeting the requirements of 40 CFR Part 50, Appendix B 9.2.1 is used as a primary standard.
- E. Differential manometer meeting 40 CFR Part 50, Appendix B 7.87 capable of measuring at least 40 cm (15.7 inches) of H₂O.
- F. Timers meeting ± 2 minute accuracy specification as per 40 CFR Part 50, Appendix B 7.7.
- G. A barometer capable of measuring the nearest mmHg as per 40 CFR Part 50, Appendix B 7.6.
- H. A thermometer capable of measuring to the nearest degree with an accuracy of ± 1 °C, as per 40 CFR Part 50, Appendix B 7.5.1.

The above requirements are listed in Table 9.

Table 9
PM₁₀/TSP Equipment Procurement
Field Sampling Equipment

Equipment	Acceptable Limits	Frequency and Method of Measurement	Action if requirement not met
Sampler	Sampler complete, see above	Visual observation	Reject or repair
Orifice calibration unit	Flow rate from Mfg. Equal actual $\pm 4\%$	On receipt, check against primary standard (semi-annually).	1) Adopt new calibration curve 2) Reject if evidence of damage
Elapsed time meter	24 hrs. ± 2 min.	On receipt, check against primary standard (semi-annually).	Reject or adjust
Positive displacement meter	Primary standard	Verify from supplier.	As above
Barometer	Accuracy to $\pm 0.2\%$	Certify prior to use and every 6 months.	Calibrate or replace
Thermometer	Accuracy ± 1 °C	Certify prior to use and annually (liquid) or every six months (electronic/ mechanical).	Replace

Table 10
PM₁₀/TSP Equipment Procurement
Laboratory Analysis Equipment

Equipment	Acceptable Limits	Frequency and Method of Measurement	Action if requirement not met
Analytical balance	See Chapter 7.	Gravimetric test weighing at purchase and during periodic calibration checks (See Chapter 7)	Have balance maintained and calibrated by manufacturer (See Chapter 7)
Thermometer	Accuracy ± 1 °C	Certify prior to use and annually (liquid) or every six months (electronic/mechanical).	Replace
Relative humidity Indicator	Indicator must equal psychrometer reading $\pm 6\%$ RH	Certify prior to use and every 6 months.	Calibrate or replace
Numbering device	Indelible ink	Upon receipt	Return
Filters	99% collection efficiency for 0.3 μm by DOP	Upon receipt	Return
Light table box	Strong opaque light source	Upon receipt	Return
Desiccator	Must accommodate 8"x 10" unfolded filter, @ 20-45%	Upon receipt	Return

5.3.2 PM_{2.5} and PM₁₀

The agency must have the necessary hand tools, electrical test equipment and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program.

The following equipment is required:

- A. PM₁₀ samplers meeting the requirements of 40 CFR Part 50, Appendix J. The sampler must collect particles at a constant flow rate under actual conditions of 1.13 m³/min \pm 10% using a flow control device.
- B. PM_{2.5} samplers meeting the requirements of 40 CFR Part 50, Appendix L.
- C. Flow measurement device accurate to within \pm 2% as per 40 CFR Part 50, Appendix J 7.1.4.
- D. Timing control device capable of starting and stopping the sampler at 24 hr \pm 1 hr intervals.
- E. Elapsed time meter accurate to \pm 2 minutes as per 40 CFR Part 50, Appendix J.
- F. Quartz fiber filters with a collection efficiency of 99 percent (DOP test - 2986) as per 40 CFR Part 50, Appendix J 7.2.2.
- G. Filter conditioning environment where temperature is maintained at 15 to 30 °C \pm 3 °C and 20-45% R.H. \pm 5% as per 40 CFR Part 50, Appendix J 7.4.1, 7.4.2, 7.4.3.
- H. Laboratory equipment meeting the requirements of Table 10.

5.3.2.1 Representative Scales

- A. Spatial Scale range from 0.1 to 0.5 km² for small area and up to 100's of km² for large area.
- B. Temporal Scale focus is on annual or geometric mean concentration, or 24 hr average concentration. For more information, refer to 40 CFR Part 50, Appendix L and J and Part 58, Appendix D and E.

5.3.2.2 PM_{2.5/10} Sampler Design Specifications

See 40 CFR Part 50, Appendix L or See Table 6-1 Design/Performance Specifications in "Model Quality Assurance Project Plan for the PM Ambient Air 2.5 Monitoring Program at State and Local Air Monitoring Stations (SLAMS)" <http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/totdoc.pdf> and Chapter 7 Part 1, Section 1.1

5.3.2.3 PM_{2.5/10} Filter Specifications

See 40 CFR Part 50, Appendix L or See Table 6-1 Design/Performance Specifications in "Model Quality Assurance Project Plan for the PM Ambient Air 2.5 Monitoring Program at State and Local Air Monitoring Stations (SLAMS)" <http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/totdoc.pdf>

- 5.3.2.4 PM_{2.5/10} Siting Criteria**
See Chapter 7, Part 1, Section 4.1
- 5.3.2.5 PM_{2.5/10} Installation Procedures**
See Chapter 7, Part 1, Section 4.2
- 5.3.2.6 PM_{2.5/10} Sampling Operations**
See Chapter 7, Part 1, Section 4.3
- 5.3.2.7 PM_{2.5/10} Calibration Procedures**
See Chapter 7, Part 1, Section 5.0
- 5.3.2.8 PM_{2.5/10} Audit Procedures, and Precision and Accuracy assessment**
See Chapter 7, Part 1, Sections 6.0 - 7.3
- 5.3.2.9 PM_{2.5/10} Maintenance**
See Chapter 7, Part 1, Section 8.0

Additional equipment that may be required for a particular agency's use is listed in Table 12.

5.4 Carbon Monoxide (CO)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program. The following equipment is required:

- A. Carbon Monoxide Analyzer meeting the specific requirements of 40 CFR Part 53, Chapter 4 of the QA Manual, and Table 7.
- B. Calibration System capable of calibrating the monitor over its full operating range. The nitric oxide cylinder gas and the NO permeation tube must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.
- C. Flow Meter capable of measuring the flow rates over the operation and calibration range of the instrument with an accuracy of $\pm 2\%$.
- D. Data Recording Device for data collection, such as a strip chart recorder or a computer.

5.5 Nitrogen Dioxide (NO₂)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program.

- A. Oxides of Nitrogen Analyzer meeting the requirements of 40 CFR Part 53, Table 7, and Table 11.

- B. Calibration System capable of calibrating the monitor over its full operating range. The nitric oxide cylinder gas must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.
- C. Flow Control Meter capable of controlling and measuring flow rates over the operating and calibrating range with an accuracy of $\pm 2\%$ as per 40 CFR Part 50 Appendix F.
- D. Data Recording Device for data collection, such as a strip chart recorder or a computer.

The above requirements are listed in Table 11.

Table 11
Nitrogen Dioxide Procurement Matrix

Equipment Chemiluminescence	Acceptance Limits	Frequency and Method of Measurement	Action if Requirements Not Met
Analyzer	Performance in accordance with specifications in Table 5	Mfg. should provide a strip chart verifying	Return to supplier
Recorder	Compatible with output	Check upon receipt, calib. speed and output annually	Return to supplier
Samples, Lines & Manifold	Construction of Teflon or glass	Check upon receipt	Return to supplier
Calibration equipment	40 CFR 50 App. F	Check upon receipt	Return to supplier
Flow meter	$\pm 2\%$ from Standard	Verify semi-annually	Return to supplier
Air flow controller	$\pm 2\%$ from Standard	Check upon receipt	Return to supplier
Pressure regulator for NO cylinder	nonreactive diaphragm, internal stable parts	Check upon receipt	Return to supplier
Ozone Generator	Capable of stable levels of Ozone	Check upon receipt	Return to supplier
Fittings & Valves	Teflon connectors	Check upon receipt	Return to supplier
Chambers & Manifolds	Nonreactive glass	Check upon receipt	Return to supplier
Working Standard	Traceable to NIST-SRM	See Chapter 6 of the QA Manual	
NO cylinder gas	Meets limits on traceability.	See Chapter 5 and 6 of the QA Manual	Return to supplier

Table 12 contains additional equipment to assist in the agency's calibrations.

5.6 Sulfur Dioxide (SO₂)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to maintain, operate, calibrate, and assure the data quality in the monitoring program.

The following equipment is required:

A. Sulfur Dioxide Analyzer meeting 40 CFR Part 53 requirements and Table 7.

Calibration System meeting the specifications of 40 CFR Parts 50 and 53, and Chapter 3 of this manual, and capable of operating the equipment over its full calibration range. The SO₂ cylinder gas must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.

B. Flow meter capable of measuring the flow rates over the operation and calibration range of the instrument with an accuracy of $\pm 2\%$.

C. Data Recording Device for data collection, such as a strip chart recorder or a computer.

Table 12
Matrix for Calibration Equipment

Equipment	Requirement	Frequency & Method of Measurement	Action if Requirements Not Met
Wet test meter	Error not to exceed $\pm 1\%$	Check upon receipt. Quarterly check with liquid positive displacement technique. See Chapter 6, IDEM/OAQ/QA manual.	Check connections, gravimetrically check volume of standard flask, and repeat calibration. If limits are met, adjust meter as per manufacturer.
Soap bubble meter	Error not to exceed $\pm 1\%$	Initial calibration upon receipt, Gravimetric displacement method. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Mass flow meter	All data points within $\pm 2\%$ of the best-fit curve	Calibrate vs. bubble or wet test meter quarterly. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Rotameter	As above	Before each field use & after sampling, calibrate vs. wet test meter. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Analytical Balance	See Chapters 7 and 8.	Initially & after moving or rough handling, or when a standard weight cannot be weighed to within tolerances specified.	Repeat check to verify malfunction.
Elapsed time meter	± 2 min/24 hrs.	Check every 6 months against an NIST standard for accuracy.	Replace time meter.
ON-OFF timer	± 15 min/24 hrs.	Perform quarterly, use calibrated elapsed time meters. See Chapter 6 of IDEM/OAQ/QA manual.	Adjust the tripper switches, replace time meter, & repeat test.
Vacuum gauge	Correct within $\pm 1"$, 25.4 mmHg	Check quarterly against calibration vacuum gauge or Hg manometer.	

5.7 Facilities

- A. Adequate space must be made available to operate, calibrate, and maintain the instruments.
- B. The space used for all reference method or equivalent instruments must be maintained at 15 to 33 °C and electrical power should be maintained at any normal line voltage between 105 and 125 V. This does not include the reference method for total suspended particulate or Meteorological parameters.
- C. The space used for all Federal reference method or equivalent instruments must prohibit direct sunlight upon the instruments or ancillary equipment. This does not include Federal reference method (High Volume Method) for total suspended particulate or Meteorological parameters.
- D. The site used for reference method (High Volume Method) for total suspended particulate must not have a dusty surface.
- E. The space used should comply with the Occupational Safety and Health Act and/or the equivalent State safety and health program requirements.
 - 1. Room space should be adequate to allow free movement for personnel. The floors should be clean, dry, and free from obstacles such as wires, cracks, etc.
 - 2. An approved fire extinguisher should be immediately accessible around instruments using combustible gases.
 - 3. Oxidizing and reducing gases should only be used in rooms with good ventilation.
 - 4. Personnel should be trained in safety and emergency procedures.
- F. All facilities and equipment must be maintained with the safety requirements for reference and equivalent method determinations. 40 CFR Part 53.4(b)3; 40 CFR Part 53.9(b).

5.8 Network Design

The air monitoring network must be designed in accordance with State Implementation Plans and subsequent requirements (40 CFR 51). There must be a Monitoring/Quality Assurance Plan describing the network that will prescribe and detail:

- A. The basis for the design of the network, selection of instruments, and sampling sites.
- B. The locations of the instruments (site locations) by Universal Transverse Mercator (UTM) grid coordinates or the equivalent.
- C. The sampling schedules.

- D. The methods of sampling and analysis.
- E. The method of data handling and analysis procedures.
- F. The calibration and quality assurance procedures.

5.9 Network Status Reporting

- A. The operator must maintain records identifying the history and status of each air monitoring site. This information must contain at least the following information:
 - 1. AQS Site Identification
 - 2. Photographs or slides of the monitoring site. One photograph or slide toward each of the four compass directions and one close-up photograph of the instrumentation at the site.
 - 3. Date site was started up and date site was shut down, as appropriate.
 - 4. Model, manufacturer, and serial number of instruments at the site and dates each instrument operated.
 - 5. Reasons for periods of missing data.
- B. The operator must maintain the correct number and type of instruments as required by the Federal Register and any State of Indiana requirements.
- C. The operator must not conduct activities that will reduce the quality and quantity of data that is required to be collected.
- D. Manual methods not identified as reference or equivalent methods are obsolete.

5.10 Network Operation and Maintenance

5.10.1 Network Operation

- A. Instrument(s) must be operated in strict accordance with the operator's written Standard Operating Procedures. Standard Operating Procedures are derived from the Federal reference or equivalent method(s), the manufacturer's instruction manual and IDEM's OAQ/QA Manual.

- B. A formal written procedure must be adhered to in the operation of the instrument(s).
 - 1. Monitoring schedule
 - a. Continuous monitoring
 - b. Intermittent monitoring
 - i. seasonal
 - ii. special study
 - 2. Operational schedule
 - a. Calibration
 - b. Zero/span checks
- C. The operator should maintain an adequate supply of expendable materials necessary to service the instrument.
- D. The high volume sample must be picked up and returned for analysis to the laboratory as soon as possible after each sampling period, preferably within 24 hours.
- E. Operating schedules (zero checks, span checks, and calibrations) for continuous monitors are determined from well documented past performance data which demonstrates that the instrument is operating within well defined limits. Examples include:
 - 1. Performance control chart(s)
 - 2. Audit results
 - 3. Collected data
 - 4. Maintenance records

5.10.2 Network Maintenance

- A. Maintenance must be performed in strict accordance with the operator's written Standard Operating Procedures.
- B. A formal written schedule must be used for performing maintenance on the instruments.
- C. This schedule should include the following: preventive, annual, quarterly, monthly, and biweekly maintenance.
- D. The operator must have immediate access to an instrument technician. This should be a staff member, but may be the instrument manufacturer's serviceman or equal. Where this capability does not exist within the operating group, a service contract is recommended.